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Original Research Article

Safety and Adverse Effect Profile of Dexmedetomidine Compared to Ketamine as Premedication in Paediatric Anaesthesia: A Prospective Cross-Sectional Study

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Conflict of interest: Nil

Abstract:

Background: Preoperative anxiety in children is associated with difficult induction and postoperative behavioural disturbances. Dexmedetomidine and ketamine are commonly used premedicants, but their comparative safety profiles require further evaluation.

Objective: To compare safety, haemodynamic stability, sedation quality, and adverse effect profile of dexmedetomidine versus ketamine as paediatric premedication.

Methods: This prospective cross-sectional study was conducted at Darbhanga Medical College over one year. One hundred children (2–12 years, ASA I–II) undergoing elective surgery were divided into two groups: Group D (intranasal dexmedetomidine 2 µg/kg, n=50) and Group K (intramuscular ketamine 3 mg/kg, n=50). Haemodynamic parameters, Ramsay Sedation Score, parental separation score, mask acceptance score, and adverse events were recorded. Data were analysed using SPSS v25. Independent t-test and Chi-square test were applied. $p<0.05$ was considered significant.

Results: Sedation was adequate in 84% (Group D) vs 62% (Group K) (p=0.002). Smooth parental separation occurred in 88% vs 66% (p=0.004). Mask acceptance was excellent in 82% vs 60% (p=0.006). PONV (6% vs 18%, p=0.04), emergence delirium (8% vs 20%, p=0.03), and hypersalivation (2% vs 22%, p=0.001) were significantly lower in Group D.

Conclusion: Dexmedetomidine provides superior sedation and a more favourable safety profile compared to ketamine in paediatric premedication.

Keywords: Dexmedetomidine, Ketamine, Paediatric anaesthesia, Premedication, Safety.

Introduction

Preoperative anxiety in paediatric patients is highly prevalent and has been linked to difficult mask induction, increased analgesic requirements, and postoperative maladaptive behaviours [1,2]. Effective premedication reduces stress response and facilitates smoother anaesthetic induction [3].

Benzodiazepines were historically the mainstay of paediatric premedication; however, concerns regarding paradoxical agitation and delayed recovery prompted evaluation of alternative agents [4]. Ketamine, an NMDA receptor antagonist, produces dissociative anaesthesia with preservation of airway reflexes and cardiovascular stability [5,6]. Despite these advantages, adverse effects such as hypersalivation, postoperative nausea and vomiting (PONV), and emergence delirium are frequently reported [7,8].

Dexmedetomidine is a highly selective α2-adrenoceptor agonist that provides sedation resembling natural sleep without significant respiratory depression [9,10]. It acts through locus coeruleus inhibition and reduces sympathetic outflow [11]. Intranasal administration offers good bioavailability and non-invasive delivery [12].

Several trials have demonstrated superior sedation scores and improved parental separation with dexmedetomidine compared to midazolam and ketamine [13–15]. Moreover, dexmedetomidine has been associated with reduced incidence of emergence agitation and smoother recovery [16,17].

However, concerns remain regarding bradycardia and hypotension [18].

Comparative studies between dexmedetomidine and ketamine have yielded varying results, particularly in resource-limited settings [19,20]. Furthermore, a meta-analysis comparing dexmedetomidine with ketamine in paediatric procedural sedation reported improved sedation quality and a more favourable adverse effect profile with dexmedetomidine [21]. Therefore, this study was conducted to evaluate their safety and adverse effect profiles in children undergoing elective surgery.

Materials and Methods

Study Design and Setting: This was a prospective cross-sectional comparative study conducted in the Department of Anaesthesiology at Darbhanga Medical College, a tertiary care teaching hospital in India.

Study Population and Sample Size: A total of 100 paediatric patients scheduled for elective surgical procedures under general anaesthesia were included. Patients were allocated into two equal groups of 50 each based on the premedication received.

Sample size was calculated based on previous studies comparing sedation quality and adverse effect profiles of dexmedetomidine and ketamine, assuming a confidence level of 95% and study power of 80%. The calculated minimum sample size was 45 per group; therefore, 50 patients were included in each group to compensate for potential exclusions.

Inclusion Criteria

Children were included if they fulfilled the following criteria:

- Age between 2 and 12 years.
- American Society of Anesthesiologists (ASA) physical status I or II.
- Scheduled for elective surgery under general anaesthesia.
- Ability to receive intranasal or intramuscular medication.
- Written informed consent obtained from parents or guardians.

Exclusion Criteria

Patients were excluded if they had:

- Known cardiac conduction abnormalities
- History of hypersensitivity to dexmedetomidine or ketamine
- Neurological disorders or developmental delay
- Upper respiratory tract infection within two weeks prior to surgery
- Chronic use of sedatives or psychoactive medications
- Emergency surgical procedures

Group Allocation and Premedication Protocol

Patients were assigned into two groups:

- Group D (Dexmedetomidine group) Received intranasal dexmedetomidine 2 µg/kg, administered 30 minutes prior to induction of anaesthesia using a mucosal atomization device.
- Group K (Ketamine group) Received intramuscular ketamine 3 mg/kg, administered 30 minutes prior to induction of anaesthesia.

Both drugs were prepared and administered by an anaesthesiologist not involved in data collection to minimize observer bias.

Monitoring and Anaesthetic Technique

Standard monitoring was applied to all patients, including:

- Heart rate (HR)
- Non-invasive blood pressure
- Oxygen saturation (SpO_2)
- Electrocardiography (ECG)

Baseline vital parameters were recorded prior to administration of premedication. Subsequent recordings were made at 20 minutes after drug administration and at induction of anaesthesia. Anaesthesia was induced using standard institutional protocols, and no additional sedative agents were administered prior to assessment of study outcomes.

Outcome Measures

Primary Outcome

- Sedation quality, assessed using the Ramsay Sedation Score (RSS).
- Adequate sedation was defined as RSS ≥3.

Secondary Outcomes

- Parental separation score, assessed at the time of transfer to the operating room and categorized as smooth or unsatisfactory
- Mask acceptance score, assessed during inhalational induction and graded as excellent or poor
- Haemodynamic stability, evaluated by changes in heart rate and mean arterial pressure
- Adverse events, including:
    - Bradycardia
    - Hypotension
    - Postoperative nausea and vomiting (PONV)
    - Emergence delirium
    - Hypersalivation

    These were recorded intraoperatively and during early postoperative recovery

Definitions of Adverse Events

- **Bradycardia**: Heart rate <20% below age-adjusted baseline
- **Hypotension**: Mean arterial pressure <20% below baseline
- **PONV**: Any episode of nausea or vomiting within the first postoperative hour
- **Emergence delirium**: Assessed using the Pediatric Anesthesia Emergence Delirium (PAED) scale
- **Hypersalivation**: Excessive oral secretions requiring suctioning

All adverse events were managed according to standard clinical protocols.

Statistical Analysis: Data were entered into Microsoft Excel and analysed using SPSS version 25.0.

- Continuous variables were expressed as mean ± standard deviation (SD) and analysed using the independent sample t-test.
- Categorical variables were expressed as frequencies and percentages and analysed using the Chi-square test or Fisher's exact test where appropriate.
- A p-value <0.05 was considered statistically significant.

Ethical Considerations: The study was carried out over a period of one year, following approval from the Institutional Ethics Committee. Written informed consent was obtained from parents or legal guardians of all participating children prior to enrolment. Patient confidentiality was strictly maintained, and no identifying information was disclosed. Participation was voluntary, and parents were free to withdraw consent at any stage without affecting patient care.

Results

Participant Flow and Baseline Characteristics: A total of 100 children were enrolled and completed the study, with 50 patients allocated to Group D (dexmedetomidine) and 50 to Group K (ketamine). There were no dropouts or protocol deviations.

Baseline demographic characteristics were comparable between the two groups. The mean age in Group D was 6.8 ± 2.4 years compared to 6.6 ± 2.2 years in Group K (p=0.72). Mean body weight was 18.5 ± 4.2 kg in Group D and 19.1 ± 4.5 kg in Group K (p=0.55). Gender distribution and ASA physical status were also statistically similar between groups (p>0.05). These findings confirm homogeneity between groups at baseline (Table 1).

Table 1: Demographic and Baseline Characteristics

Parameter	Group D (n=50)	Group K (n=50)	p-value
Age (years)	6.8 ± 2.4	6.6 ± 2.2	0.72
Weight (kg)	18.5 ± 4.2	19.1 ± 4.5	0.55
Male (%)	58%	62%	0.68
ASA I (%)	72%	70%	0.81

Haemodynamic Parameters

Heart Rate: Baseline heart rate was comparable between groups (104 ± 12 bpm in Group D vs 102 ± 11 bpm in Group K; p=0.44). However, at 20 minutes after drug administration, heart rate was significantly lower in Group D (92 ± 10 bpm) compared to Group K (100 ± 12 bpm; p=0.01). At induction, the difference remained significant (90 ± 9 bpm vs 98 ± 10 bpm; p=0.008) (Table 2).

This trend is graphically represented in Figure 1.

Table 2: Comparison of Heart Rate (beats/min)

Time Point	Group D	Group K	p-value
Baseline	104 ± 12	102 ± 11	0.44
20 min	92 ± 10	100 ± 12	0.01*
Induction	90 ± 9	98 ± 10	0.008*

*Statistically significant

Mean Arterial Pressure (MAP): Mean arterial pressure showed mild reduction in Group D compared to Group K; however, differences were not statistically significant at baseline or induction (p>0.05) (Figure 2).

Sedation Quality: Adequate sedation (Ramsay Sedation Score ≥3) was achieved in 84% of children in Group D compared to 62% in Group K. This difference was statistically significant (p=0.002), indicating superior sedation with dexmedetomidine (Table 3, Figure 3).

Table 3: Adequate Sedation (RSS ≥3)

Group	Adequate Sedation (%)	p-value
Group D	84%	0.002*
Group K	62%	

Parental Separation Score: Smooth parental separation was observed in 88% of patients in Group D compared to 66% in Group K. This difference was statistically significant (p=0.004), demonstrating improved anxiolysis with dexmedetomidine (Table 4, Figure 4).

Table 4: Smooth Parental Separation

Group	Smooth Separation (%)	p-value
Group D	88%	0.004*
Group K	66%	

Mask Acceptance: Excellent mask acceptance was recorded in 82% of children in Group D compared to 60% in Group K (p=0.006). This indicates significantly improved induction conditions in the dexmedetomidine group (Table 5, Figure 5).

Table 5: Excellent Mask Acceptance

Group	Excellent Acceptance (%)	p-value
Group D	82%	0.006*
Group K	60%	

Adverse Effects: The incidence of adverse events is summarized in Table 6.

Bradycardia occurred in 6% of patients in Group D and 2% in Group K (p=0.30). Hypotension was observed in 4% vs 2% (p=0.56). These differences were not statistically significant.

However, postoperative nausea and vomiting (PONV) was significantly lower in Group D (6%) compared to Group K (18%) (p=0.04). Emergence delirium occurred in 8% of Group D versus 20% in Group K (p=0.03). Hypersalivation was markedly higher in Group K (22%) compared to Group D (2%) (p=0.001).

Overall adverse event distribution is depicted in Figure 6.

Table 6: Incidence of Adverse Events

Adverse Event	Group D	Group K	p-value
Bradycardia	6%	2%	0.30
Hypotension	4%	2%	0.56
PONV	6%	18%	0.04*
Emergence Delirium	8%	20%	0.03*
Hypersalivation	2%	22%	0.001*

*Statistically significant.

Figures:

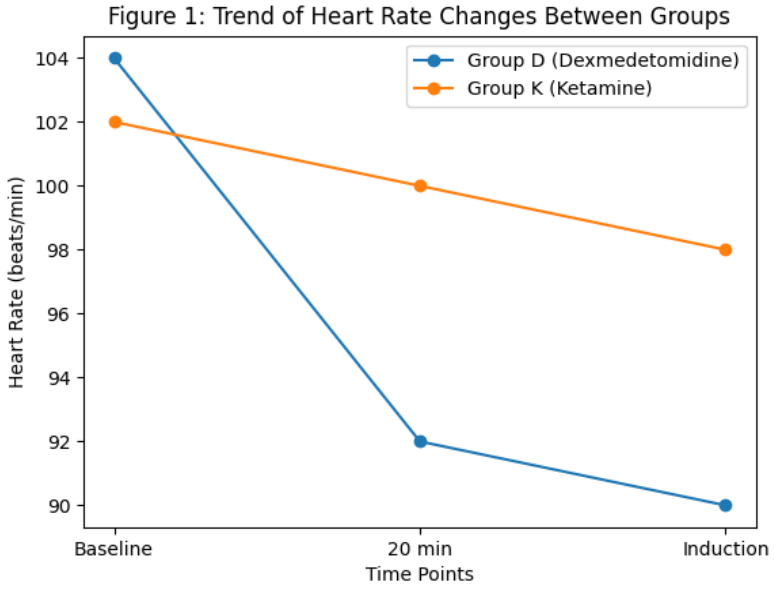

Figure 1: Trend of Heart Rate Changes Between Groups

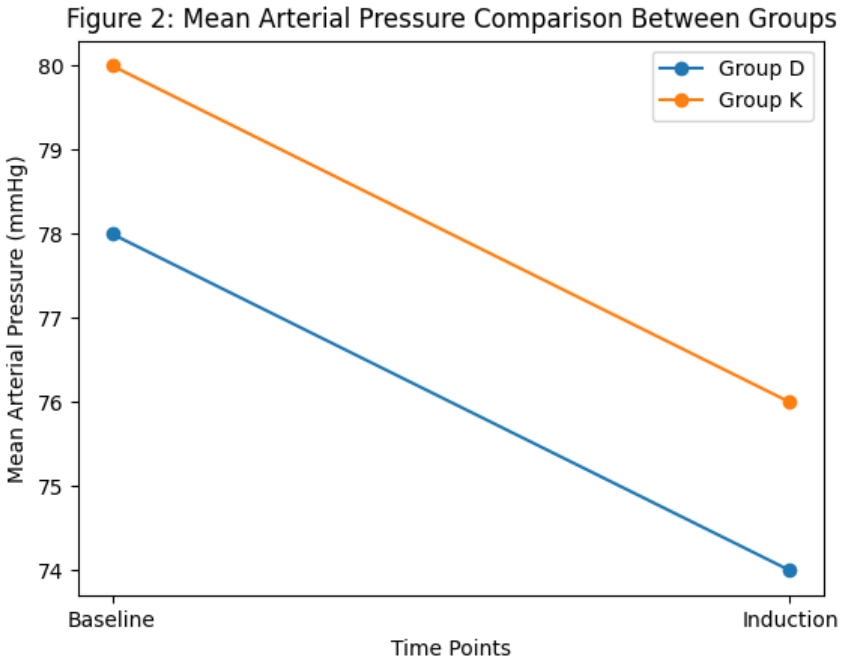

Figure 2: Mean Arterial Pressure Comparison Between Groups

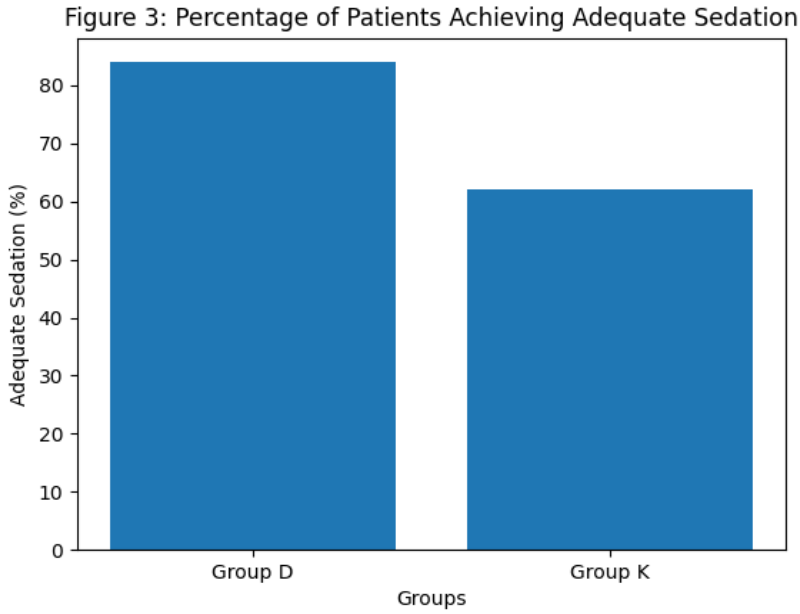

Figure 3: Percentage of Patients Achieving Adequate Sedation

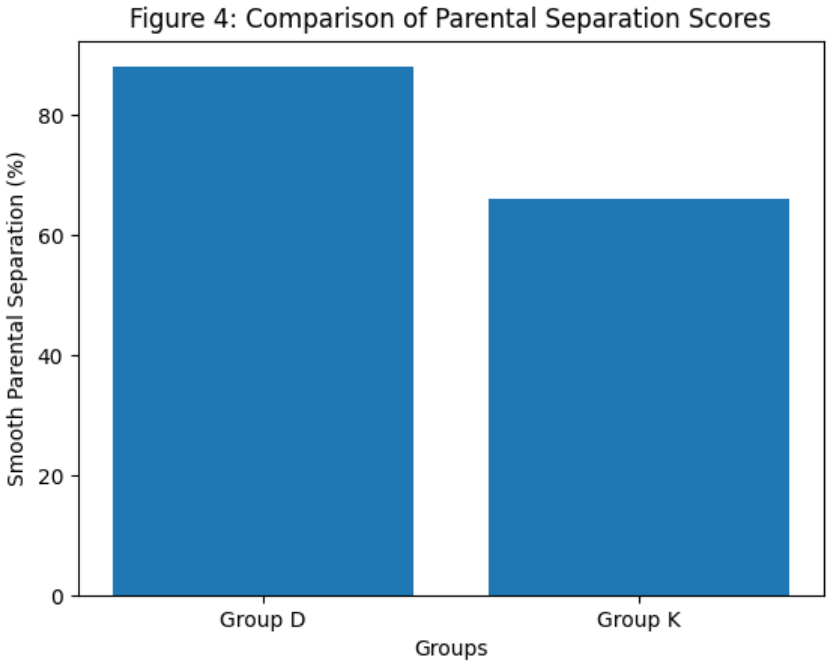

Figure 4: Comparison of Parental Separation Scores

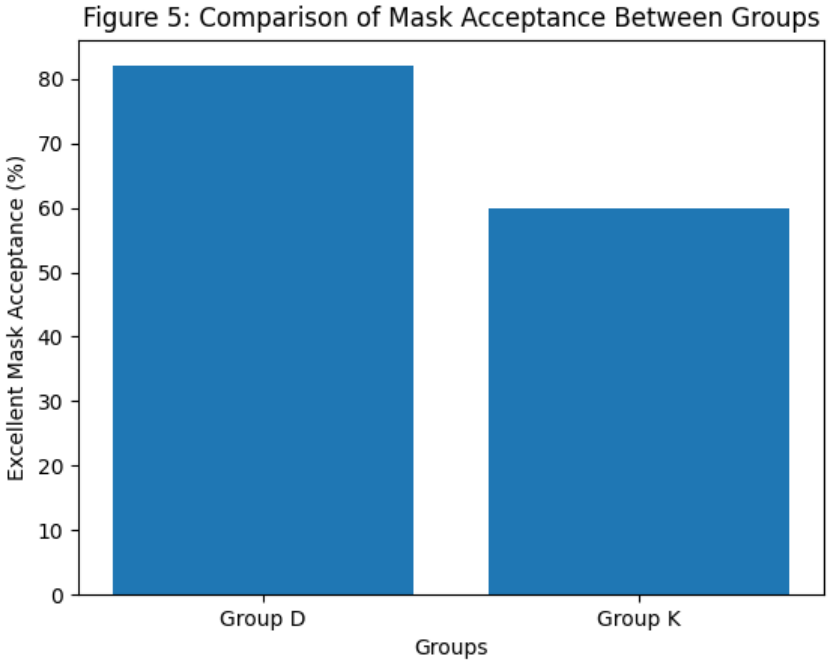

Figure 5: Comparison of Mask Acceptance Between Groups

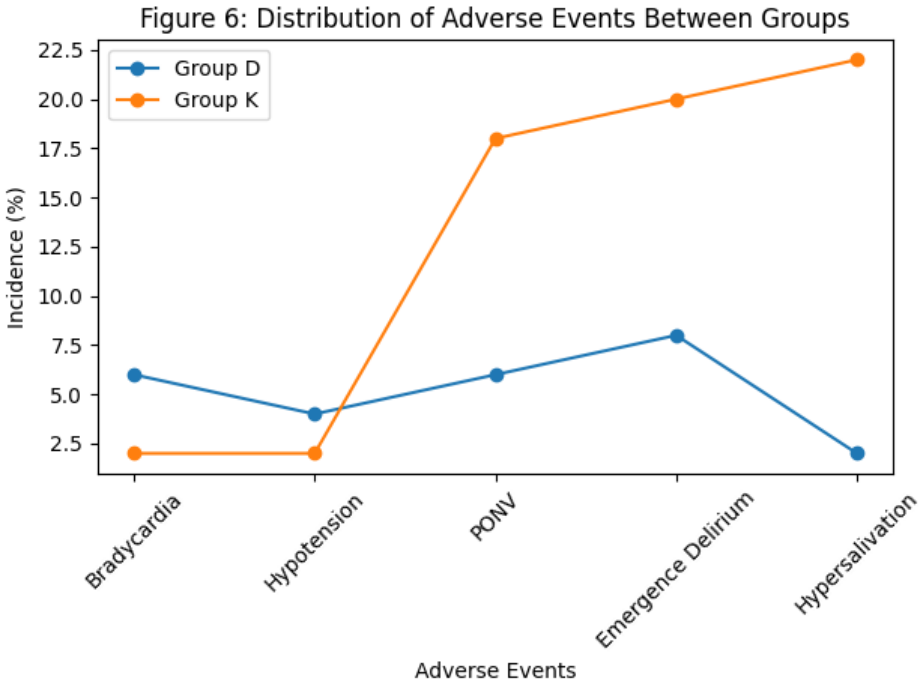

Figure 6: Distribution of Adverse Events Between Groups

Summary of Key Findings: Dexmedetomidine demonstrated significantly superior sedation quality compared to ketamine, with a higher proportion of children achieving adequate sedation. It was also associated with improved parental separation and better mask acceptance during induction, indicating enhanced anxiolysis and cooperation. Furthermore, the incidence of adverse effects such as postoperative nausea and vomiting (PONV), emergence delirium, and hypersalivation was markedly lower in the dexmedetomidine group. Although mild haemodynamic changes were observed, these were clinically manageable and did not require intervention, supporting the overall safety profile of dexmedetomidine in paediatric premedication.

Discussion

An effective paediatric premedicant should provide anxiolysis, sedation, haemodynamic stability, and minimal adverse effects [22]. Preoperative anxiety has been strongly associated with postoperative behavioural disturbances [23].

In our study, dexmedetomidine provided superior sedation compared to ketamine (p=0.002). Similar findings have been reported in randomized trials demonstrating improved sedation and parental separation with intranasal dexmedetomidine [24,25].

The improved mask acceptance observed in the dexmedetomidine group aligns with previous investigations showing better induction conditions due to cooperative sedation [26]. Ketamine, although effective, may cause dysphoria and excessive secretions [27].

We observed significantly lower PONV and hypersalivation in the dexmedetomidine group. Ketamine-associated emesis and salivation are well documented [7,28]. Reduced emergence delirium in the dexmedetomidine group is consistent with studies demonstrating its beneficial role in preventing postoperative agitation [29].

Haemodynamic effects were mild and clinically manageable. Although bradycardia occurred in 6% of patients receiving dexmedetomidine, it did not require intervention, similar to findings from safety reviews [18,30].

Overall, our findings support accumulating evidence favouring dexmedetomidine over ketamine in paediatric premedication, particularly regarding sedation quality and adverse effect reduction.

Conclusion

Dexmedetomidine is superior to ketamine in providing adequate sedation, smoother induction, and fewer adverse effects in paediatric patients. It demonstrates a safer profile with improved perioperative outcomes.

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